

Poster Exhibit

BOTH SIDES NOW

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On November 2, 1986 of the cirrus Intensive Field Observations, cirrus clouds were observed from both ground-based and aircraft lidar. The NASA ER2 aircraft carrying a lidar, crossed Madison three times and Wausau five times during its mission. Ground-based lidars from the University of Wisconsin in Madison and the University of Utah in Wausau were operating during the ER2 overpasses. This gave FIRE unique lidar observations of cirrus clouds from both sides.

Cloud cover on November 2 was absent from most of the FIRE observation area at the start of the ER2 mission (Fig. 1). There was a long line of cirrus and alto stratus clouds south of Madison. This cloud line was over Madison on the previous day and had moved south. Southern Wisconsin experienced very dry and cloudy skies. Cirrus clouds encroached upon the FIRE study area from the northwest. The clouds in northwestern Wisconsin were generally multi-layered cirrus clouds from 5 to 10 km altitude. The cloud layers were thin in central Wisconsin and thickened to the northwest. These clouds proceeded the warm front which approached Wisconsin from Canada.

The movement of these cirrus clouds into Wisconsin is depicted by the time section of lidar data from Wausau (Fig. 2). Two separate layers of clouds were observed in the morning at 6-7 km and 10-11 km. After local noon (1800 GMT), the cloud layers thickened into one nearly solid cloud mass from 5 to 11 km.

The NASA ER2 aircraft initially flew over the cloud band in Illinois south of Madison. Lidar tracks were taken going south into the cloud band along the band flying west, and flying north toward Madison away from the band. The aircraft crossed Madison at 18:49 GMT when there were no clouds present and extremely clear skies. It then proceeded north to Wausau at 19:00 GMT crossing first on a northward track and the four additional east-west tracks. The last lidar cross section over Wausau is shown in Fig. 3 (19:59 GMT).

The ER2 lidar vividly depicts the cloud top altitudes. A return from the ground also can be seen part of the time. Cloud interval structure and intermediate layers are sometimes visible to the lidar. The variable height of the cloud top is most apparent in Figs. 2 and 3. There appeared to be a high layer over Wausau (AUW) at 10.8 km. This gave a strong lidar return to the ER2 from 19:00 to 19:30 GMT. This was near the cloud tops found earlier by the ground-based lidar. A second lower layer at 7.6 to 9.2 km also is partially visible on the last ER2 crossing of Wausau and to the west (Fig. 3). The lidar picked up variable and broken cloud tops. Another high layer was apparent at the end of the track.

The height of the highest cloud layers found by the ER2 lidar are indicated on the time section from the Wausau ground-based lidar as thick horizontal bars (Fig. 2). It is apparent that the cloud tops remained at 10.7 to 11 km until 19:45 GMT. The ground-based lidar is unable to define the cloud top after 19:00 GMT because of obstructing thicker cloud layers from below. Many variations in the cloud top height and cloud density were found by the ER2. At 19:50 GMT, the ground-based lidar appeared to correctly identify some of the heights reported from the ER2. The heights of the lower layers seen on the ER2 data are depicted on the time section as horizontal bars connected by a thin line. The positions of the bars in time were drawn assuming advection of the broken cloud top over Wausau. The height of the broken cloud layers appear to match some of the cloud tops found by the ground-based lidar.

These lidar cross section show the layered and broken structure of the cirrus clouds. At least two layers were observed during the morning. Later during the afternoon, the layers were not easily discernible. The special structure indicated several breaks in the cloud top ranging from 5 to 50 km in width. Similar scales also were found on the Madison lidar as the edge of the cloud mass moved south during the day.

Satellite cloud top analyses also indicated variable cloud top heights (Fig. 4). The GOES/VAS cloud top analysis was made at 20:18 GMT, approximately 25 minutes after the ER2 cross section. Satellite-derived cloud top heights were generally lower than the cloud tops visible from the ER2. This relationship has been commonly observed in other comparisons of the GOES/VAS cloud analyses to lidar data. Less variable cloud top heights were found by the GOES/VAS analysis to the north of Wausau. More radiatively dense clouds were found in this region by the GOES/VAS system.

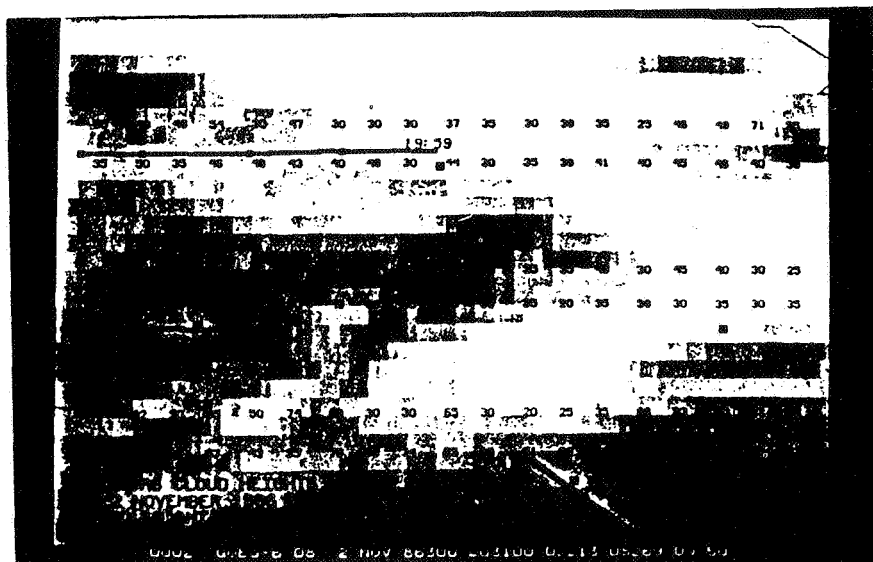


Figure 1: The locations of lidar cross sections made by the ER2 on November 2, 1986.

GOES-VAS satellite multi-spectral infrared analysis of cloud top heights for 20:18 GMT (25 minutes after the lidar cross section shown in Fig. 4).

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University of Utah Lidar at Wausau Wisconsin

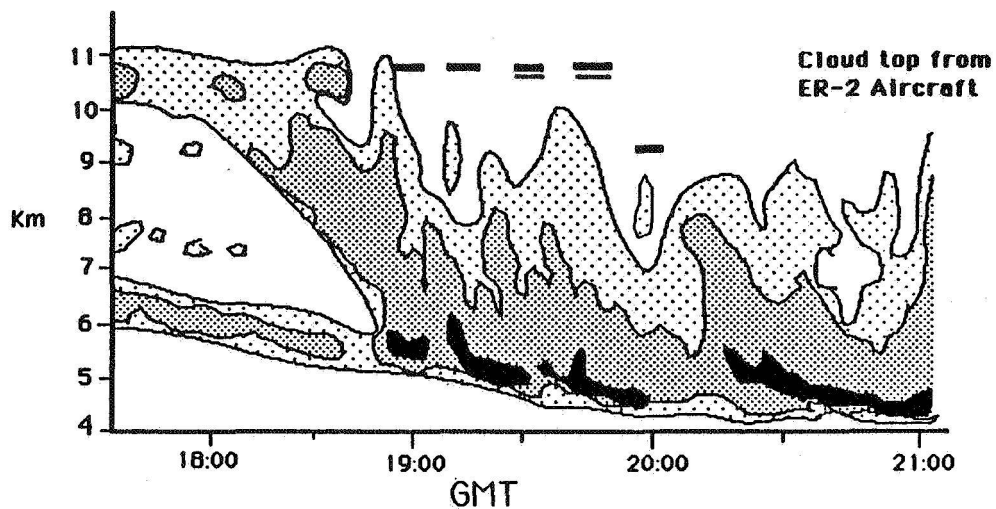


Figure 2: Composite picture of the ground-based University of Utah lidar (operated by Dr. K. Sassen) time section from Wausau, Wisconsin. Shaded areas indicate the strength of the backscattered return (uncalibrated). The mean height of the highest cloud tops from ER2 lidar crossing over Wausau are depicted as

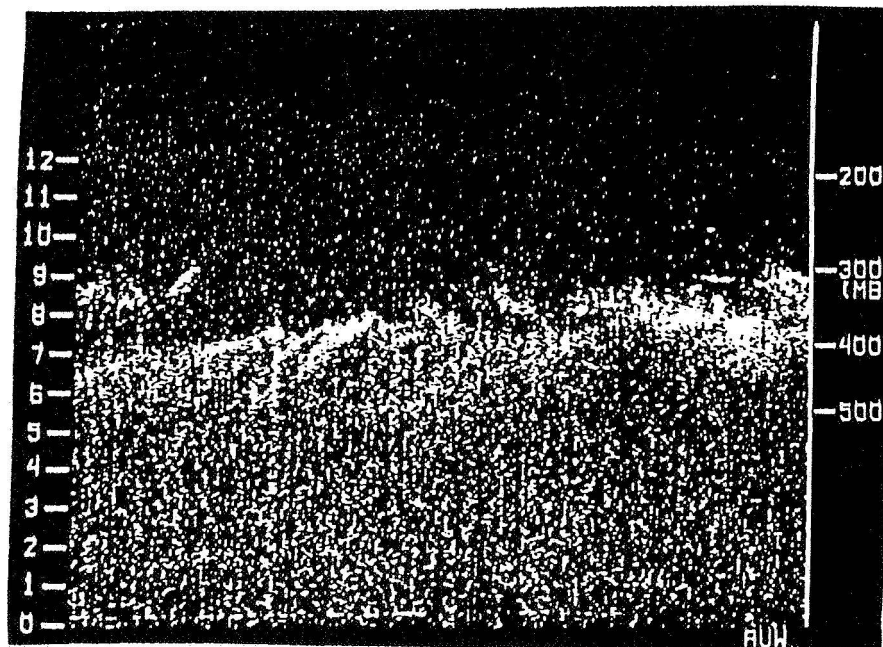
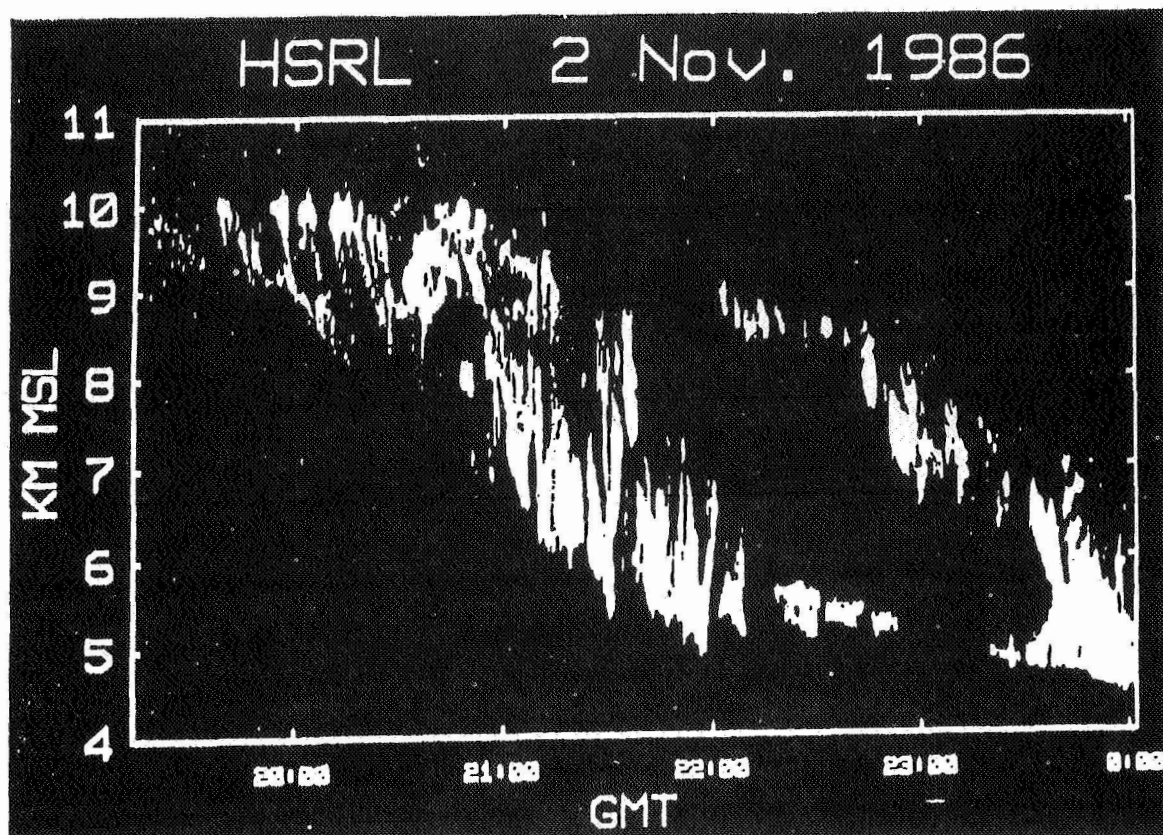
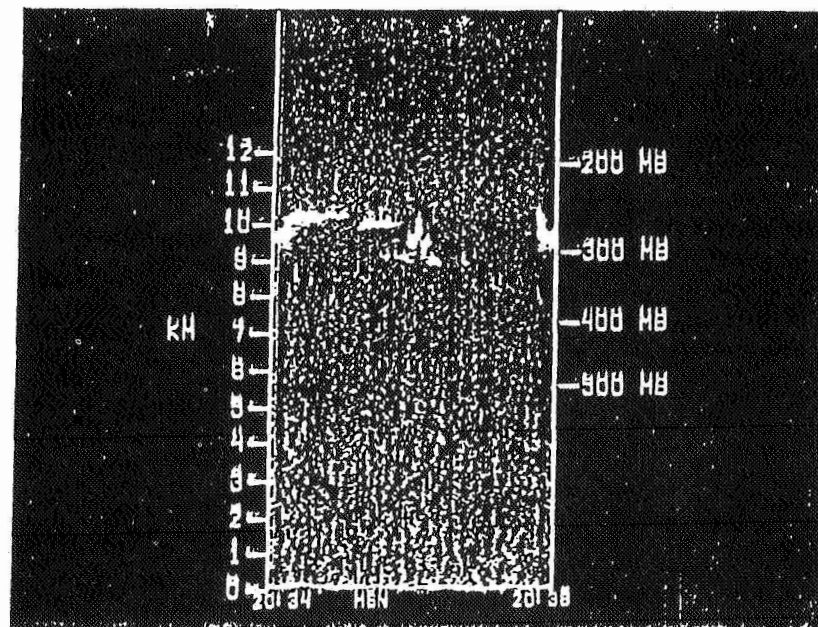


Figure 3: Cross section of lidar returns from the ER2. Brightness (white) indicate the strength of the return (uncalibrated).



Madison Lidar



ER 2 Aircraft

Figure 3 Continued